Occurrence and quantification of Arbuscular Mycorrhizal fungi of solanaceous vegetable crops in Marathwada

Synopsis

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Introduction

The Marathwada region falls in Deccan Plateau Zone of India. It is basically an intense agrarian region with geographical area of 6.5 M ha occupying 21 per cent of total area of the Maharashtra State of India. The region is rocky and dry with low and uncertain rainfall. The rivers and rivulets remain dry for major part of the year. The region lacks natural resources and is prone to drought. Marathwada region consists of eight districts i.e. Aurangabad, Jalna, Parbhani, Hingoli, Nanded, Osmanabad, Beed and Latur. About 95% of agriculture is dry land farming. Cotton, Sorghum, Sunflower, Pigeonpea are the major crops. Region also contributes in fruit crops like Oranges, Grapes, Papaya, Ber, Lime and vegetable crops like Tomato, Brinjal, Chilli, Cucurbits, Cabbage, Spinach, Fennugreek etc.

Vertisols of Marathwada region is classified as course shallow soils, medium black soils and deep black soils. The fertility index with respect to Nitrogen and Potash varies in all the districts of Marathwada.

Farmers use more chemical fertilizer, due to this practice farmers increase cost of cultivation and decrease soil fertility, productivity, created lot of soil and environmental problem. They also decrease economic status day by day.

Arbuscular mycorrhizal fungi are found in roots and plant rhizosphere soil. They have potential for sustainable agriculture. AMF live in symbiotic relationship with cultivated and non cultivated plants. Arbuscular

mycorrhizal fungi are the most significant microbes in terrestrial ecosystems which enhance the growth of entire plant and often control certain plant pathogens. Mycorrhizal fungi improve plant vigour and soil quality by secreting some extracellular enzymes and efficiently absorb the maximum amount of available nutrients from the soil for plants.

Plants of family Solanaceae are distributed in warmer region of the world. Potato, (*Solanum tuberosum L.*), Brinjal (*Solanum melongena* L.), Tomato (*Lycopersicum esculantum* Mill.) and Chilli (*Capsicum annum* L.) are the vegetable crops of Solanaceae consumed every day. Tomato is one of the most consumed vegetables in the world and is the dietary source of vitamins, minerals and fiber, which are important for human nutrition and health. Chili (red pepper) is used to flavor food and make sauces. Chilli derivatives are used in a wide variety of medicinal applications. Brinjal is popular vegetable with quite high nutritive value and contains an alkaloid called "solanine"

Aims and objectives

The present research programmae has the following objectives.

1) Survey of solanaceous vegetable crops growing in various districts of Marathwada and selection of the economically important vegetable crops *viz.*, Chilli (C. *annum* L.), Brinjal (S. *melongena* L.), Tomato (L. *esculantum* Mill.) etc.
2) Assessment of arbuscular mycorrhizal fungal colonization in root of selected vegetable crops.
3) Isolation of native arbuscular mycorrhizal fungal spores from the rhizosphere soil of selected plants.
4) Quantification of AMF spores from rhizosphere of different districts of Marathwada region.

5) Taxonomic identification of the arbuscular mycorrhizal fungal species.
6) To study the physico-chemical characters of soil collected from rhizosphere of selected plants.
7) To develop native arbuscular mycorrhizal fungi inoculum using different host plants for inoculation.
8) To study the growth response of arbuscular mycorrhizal fungi and other fungal species on selected plant species.
9) To assess the biochemical effects of AM fungi with biocontrol agents on selected crops.

METHODOLOGY

1) Survey of solanaceous vegetable crops.
2) Collection of the rhizosphere soil samples and root samples.
3) Examination of the roots to find out percent colonization using Phillips and Haymans method (1970).
4) Isolation of native arbuscular mycorrhizal fungal spores from the rhizosphere soil samples by wet sieving and decanting method (Gerdemann and Nicolson, 1963;).
5) Degree of root colonization by using root, slide method (McGoningle et al., 1990; Giovannetti and Mosse, 1980).
6) Quantification of spores and sporocarps of abuscular mycorrhizal fungi in the rhizosphere soil samples (Gaur & Adholeya, 1994; Muthukumar et al., 1996).
7) Identification of spores and sporocarps of arbuscular mycorrhizal fungi isolation was done by using various bibliographies (Schenck and Perze, 1990; Bukhari and Rodrigues, 2006; Muthukumar, 2005; and Koske et al., 1986)

8) Mass multiplication of selected native arbuscular mycorrhizal fungal spores using by funnel technique (Rodrigues, 2006; Habte and Osorio, 2001).
9) Physicochemical characters of collected rhizosphere soil and biochemical characters of control and experimental Brinjal ,Chilli and Tomato plants were assessed. Macro and micronutrients were evaluated as per 'Methods Manual Soil Testing in India' Department of Agriculture & Cooperation Ministry of Agriculture Government of India, 2011. Nitrogen (N) was assessed by micro-kjeldhal method (Jackson, 1973), Phosphorus (P) by Bray & Kurtz, 1945 and Olsen et. al., 1954. Iron (Fe), Copper (Cu), Manganese (Mn) and Zinc (Zn) by Atomic absorption spectrophotometer method.

OBSERVATION

The present investigation was made in the thesis and divided in to eight chapters.

Survey of vegetation

The survey data is a powerful tool for farmers, traders, and researchers. The survey of solanaceous vegetables was done to collect information on the areas of vegetables grown. The data collected relates Marathwada with Maharashtra and National level. Out of eight districts of marathwada region we have selected six districts viz, Osmanabad, Latur, Parbhani, Beed, Jalna, and Aurangabad. The survey was done during October 2010 to March 2011. The objective of this work was to study the different types of vegetables used by localities and find out the data of various districts. It was observed that among all the districts surveyed all the three selected plants were grown to fulfill local needs. Areas near the all district places have more cultivation than remote areas.

Assessment of arbuscular mycorrhizal root colonization

The study of mycorrhizal colonization with respect to Chilli, Brinjal and Tomato root from all sites. The extent of colonization varies among different plant and sites. In Tomato it is ranging from 43.03 to 81.94 %, in Chili it is ranging from 38.54 to 73.36 % and in Brinjal it is ranging from 30.12 to 81.93 %.

Isolation and quantification of spores

The study of mycorrhizal spore status of solanaceous vegetable rhizosphere showed variation. The study revealed that all the plants were showing spores in the vicinity of roots. The study represents rich diversity of arbuscular mycorrhizal fungi. The spore density ranged from 189 to 807 spores per 100 gram in tomato rhizosphere soil. The spore density ranged from 76 to 483 in Chili and from 91 to 598 spores per 100 gram in Brinjal soils. The study revealed that the spore density and spore diversity varied with increased moisture and type and content of soil.

Taxonomic identification of the arbuscular mycorrhizal fungal species.

The aim of this study was to identify and describe the species isolated during the study period. The spores were identified based on various morphological characteristics. The identification of arbuscular mycorrhizal fungal species from collected rhizosphere soil was done by available literature. The arbuscular mycorrhizal fungi recorded belonged to five genera viz. *Acaulospora, Gigaspora, Glomus, Sclerocystis* and *Scutellospera*. Frequently observed Arbuscular mycorrhizal fungi were *Acaulospora scrobiculata* Trappe, *Acaulospora delicata* Walker,pfeiff. and Bloss, *Acaulospora elegans* Trappe & Gerd., *Glomus aggregatum* Schenck and Smith emend.Koske, *Glomus fasciculatum* (Thaxter) Gerd. & Trappe., *Glomus geosporum* (Nicol.and Gerd.) Walker, *Glomus fistulosum* Skou &

Jakobsen, *Glomus multicaule* Gerd. and Bakshi, *Glomus mosseae* (Nicol.and Gerd.) Gerd. and Trappe, *Gigaspora decipens* Hall & Abbott. *Scelerocystis sinuosa* Gerd. and Bakshi.

Physico-chemical characters of soil

Soil texture determines water holding capacity, retention of nutrients and aeration of soil. Soil fertility refers to the amount of nutrients available to plants in the soil. Soil fertility varied from site to site and depends on microbiota, previous crop and addition of organic manure by farmers. Chemical elements are known to be important for plant's growth and survival. Plants use primary macro nutrients like Nitrogen (N), Phosphorus (P), and Potassium (K) in large amounts for their growth and survival. The secondary macro nutrients like Calcium (Ca), Magnesium (Mg), and Sulfur (S) are usually enough in soil. Sulfur is usually found in sufficient amounts. Micronutrients are essential for plant growth in only very small or trace quantities. Of the micronutrients Manganese (Mn) is in less amount (0.26 ppm) while copper (Cu) is in more amount (14.47 ppm) than standard. Boron (B), Iron (Fe), Molybdenum (Mo) and Zinc (Zn) are in sufficient amount .

Mass multiplication of native AMF spores for inoculation

This chapter deals with the mass multiplication of native arbuscular mycorrhizal fungi using *Triticum aestivum* and *Sorghum vulgare, Zea Mays*, and *Helianthus annus* as host plant. The objective of this work was preparation of inoculum. The study reveals that all the selected plants help to increase indigenous AMF spore count.

Growth response of plants to arbuscular mycorrhizal fungi and other fungal species

The chapter deals with the interaction of arbuscular mycorrhizal fungi with other soil borne fungi. The aim of this study was to evaluate the growth response of Brinjal, Tomato and Chilli to indigenous arbuscular mycorrhizal fungi and other soil fungi like *Trichoderma harzianum, Trichoderma viride*, *Aspergillus niger , Alternaria solani, Rhizopus stolonifer*. The aim of this study was to observe the effect of AMF and other fungi on root and shoot growth which is important in farmers point of view. It was observed that the plants inoculated with the mixture of arbuscular mycorrhizal fungi and *Trichoderma* species showed increased growth as compared other fungi. Increase in fresh and dry weight, number and size of leaf, root and shoot length was observed in the plant.

Biochemical effects of AM fungi with biocontrol agents on selected crops

In this chapter the biochemical response of plant species to indigenous arbuscular mycorrhizal fungal species was studied. The aim of this study was to evaluate the biochemical changes in Chilli (*C. annum* L.), Brinjal (*S. melongena* L.), Tomato (*L. esculantum* Mill.) due to mycorrhization. It was observed that the plants inoculated with arbuscular mycorrhizal fungi showed increased biochemical contents as compared to the uninoculated ones (control). Increase in N, P, K, Fe, Cu, Mn, Zn, were observed in AMF inoculated plant species than uninoculated ones.

Conclusion

The present study represents a rich diversity of AM fungi in Chilli (*C. annum* L.), Brinjal (*S. melongena* L.), Tomato (*L. esculantum* Mill.) of Marathwada region of Maharashtra state. All the three species studied were found to be mycorrhizal. Variations in spore density, diversity and percent root colonization of AM fungi were observed in different districts. Percent

root colonization and spore density of AM fungi varies with soil properties. *Sorghum* is better for AMF inoculum production than other plants studied. Plant inoculated with indigenous AM fungi has shown improved biochemical contents as compared to uninoculated ones. Plants inoculated with AM fungi mixed with other soil fungi have shown improved plant growth as compared to the AMF inoculated ones.

The present investigation forms a basis for mass multiplication and application of AM fungal species in the plants studied as well as plants cultivated in region. These easily available fungi can be used as a biofertilizers and bioprotectants in future. It also helps in improvement of plant productivity of the region.

Therefore this scientific research in Marathwada region involves multidisciplinary approaches to understand presence of mycorrhizae in rhizosphere soil, root colonization and its effect on plant growth.

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